



## BIOLOGY 5100: Microbiology in Health and Disease Department of Biological Sciences: Fall 2021 – Summer 2022

BIO5100: Course Coordinators:

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### Course Information

**Catalog description:** (4 credits, 6 hours). For students preparing for Nursing, Physician's Assistant, and other allied health sciences only. This course examines the role of microbes as infectious agents responsible for a wide variety of diseases and medical conditions. Disease transmission, treatment, and prevention are considered. The laboratory focuses on the basic methods to cultivate, identify and control microbial growth. **This course does not satisfy the Biology major elective requirement.**

**Prerequisite:** Bio 1200

**Co-requisite:** Nursing students must take Bio 5100 before or with Nursing 21. Nursing students who withdraw from Bio 51 cannot continue in NUR 2100

### Course Overview

- Major diseases caused by microorganisms are considered. These include: HIV, opportunistic and nosocomial infections, tuberculosis, hepatitis, pneumonia, sexually transmitted diseases, and water and foodborne diseases.
- The course has direct application to medical, surgical, and nursing fields.
- Universal precautions, asepsis, and control of microbial growth are emphasized.
- Immune responses to infections are discussed.
- Your knowledge of anatomy and physiology will be applied to understand the effects of microbial infections on various organ systems. If you are unsure of any of the anatomy and physiology principles being discussed, please review them or meet with your instructor.

### Course Goals for Student Outcomes

1. Apply the concept of asepsis and its applications to laboratory procedures, hospitals, & medical practices.



2. Employ basic principles of microbial anatomy and physiology to microbial virulence, pathogenicity, and disease establishment.
3. Identify the factors affecting microbial virulence and the responses by the host's defense mechanisms.
4. Determine properties of microorganisms through staining and biochemical testing that can be used for diagnostic microbial identification.
5. Recognize the signs and symptoms of a particular disease and decisions involved in determining antimicrobial therapy.

### Recommendations to Students

- Read assigned lecture and laboratory material before coming to class.
- Ask questions and meet your instructor during office hours to clarify any questions you may have.
- Attendance to class is essential. If you do miss class you are responsible for making up the missed work.
- Plan your work and study time. Read over or perhaps rewrite your notes after class. Read the text to supplement your notes. Discuss the material with your classmates. Form study groups.
- Best wishes for your success in the course. If you have any questions, please feel free to meet with your instructor.

### Access-Ability Services

Access-Ability Services (AAS) serves as a liaison and resource to the KCC community regarding disability issues, promotes equal access to all KCC programs and activities, and makes every reasonable effort to provide appropriate accommodations and assistance to students with disabilities. Please contact this office if you require such accommodations and assistance. Your instructor will be glad to make the accommodations you need, but you must have documentation from the Access-Ability office for any accommodations.

### Academic Integrity

Your instructor upholds the KCC policy on academic honesty (see Student Handbook online). There are consequences for cheating on exams or plagiarizing someone else's work (i.e., turning in work copied from another source). These include a reduced grade or zero, suspension, or dismissal. If you are not sure what constitutes academic dishonesty, please check with the instructor.

Plagiarism is the use of others' words and/or ideas without clearly acknowledging their source. As students, you are learning about other people's ideas in your course texts, your instructors' lectures, in-class discussions, and when doing your own research. When you incorporate those words and ideas into your own work, you need to give credit where it is due. Plagiarism, intentional or unintentional, is considered academic



dishonesty and all instances can be reported to the Academic Judiciary. To avoid plagiarism, you give the original author credit whenever you use another person’s ideas, opinions, drawings, or theories as well as any facts or any other pieces of information that are not common knowledge. Additionally, quotations of another person’s actual spoken or written words, or a close paraphrasing of another person’s spoken or written words, need to be referenced. Accurately citing all sources and putting direct quotations – of even a few key words – in quotation marks are required.

**Grade Computation**

Lecture and laboratory are each 50% of the final grade.

<b><u>Lecture</u></b>		<b><u>Laboratory</u></b>	
Examinations	30%	Quizzes	25%
		Clinical unknowns	15%
Final examination	20%	Practicals	10%

**Required Textbook, Laboratory Manual, and Other Materials**

**This is a Zero Textbook Cost course.**

**Text:** OpenStax. Microbiology by Parker, Schneegurt, Tu, Forster and Lister

**Lab manual:** Selected exercises of Laboratory Exercises in Microbiology by Brancaccio-Taras will be shared with you via Blackboard course site

**Materials:** Knee length laboratory coat and safety goggles. These requirements conform to OSHA safety regulation and need to be worn at all times in the microbiology laboratory. You will not be able to remain in the laboratory without a lab coat or safety goggles. After each week’s lab, the lab coat should be washed.

**BIO 51 LECTURE OUTLINE AND READING ASSIGNMENTS**

**Session 1: INTRODUCTION AND HISTORY OF MICROBIOLOGY**

Organisms studied in microbiology (prokaryotic and eukaryotic)

The nature microbiological problems

The history of microbiology

**Reading Assignment:** [The Invisible World- Chapter 1](#); [Spontaneous Generation and Germ Theory- 3.1-3.2](#); [Acellular Pathogens- Chapter 6 \(overview and life cycle\)](#)

**Session 2: BACTERIAL ANATOMY**

Bacterial shapes and arrangements

Cell wall

Cell membrane

Glycocalyx

Endospores

Flagella

Cytoplasmic inclusions



Cytoplasmic structures/organelles

**Reading Assignment:** [Unique Characteristics of Prokaryotic and Eukaryotic Cells- 3.3-3.4](#)

### **Session 3: BACTERIAL GENETIC TRANSFER & GROWTH**

3 major modes of bacterial genetic transfer: transformation, conjugation, & transduction

Significance of genetic transfer

Bacterial cell division

Bacterial growth curve

**Reading Assignment:** [Mechanisms of Microbial Genetics- 11.6](#); [Microbial Growth- Chapter 9](#)

### **Session 4: MICROBIAL METABOLISM**

Aerobic respiration

Anaerobic respiration

Fermentation and types of fermentation

Use of metabolic properties to identify microorganisms

Industrial uses for microbial metabolism- food, antibiotic, and enzyme production

Antibiotic therapy

**Reading Assignment:** [Microbial Metabolism- 8.1-8.5](#); [Antibiotic Therapy Chapter- 14](#)

### **Sessions 5 & 6: IMMUNOLOGY**

Normal flora, transient flora opportunistic microbes

Pathogenicity, virulence, and factors that increase virulence (enzymes, toxins)

Factors that affect the spread of disease

Nonspecific immune responses

Specific immune responses: humoral and cell mediated immunity

Vaccines

HIV/AIDS

**Reading Assignment:** [Microbial Mechanisms of Pathogenicity- Chapter 15](#); [Disease and Epidemiology- Chapter 16](#); [Innate Nonspecific Host Defenses- Chapter 17](#); [Adaptive Specific Host Defenses- Chapter 18](#)

### **Session 7: MICROBIAL DISEASES OF THE SKIN AND EYES**

#### **Bacterial diseases of the skin**

Acne, folliculitis, boils, furuncles, carbuncles, impetigo, cellulitis, & osteomyelitis

Infections of burns and surgical wounds, gangrene

Leprosy

#### **Viral Diseases of the Skin**

Warts



Chicken pox and shingles

Herpes (HSV I)

Measles

German measles (Rubella)

Smallpox

### **Fungal Diseases of the Skin**

Dermatophyte infection (Tinea infections)

Candidiasis

### **Bacterial diseases of the Eyes**

Conjunctivitis

### **Atypical bacterial diseases of the Eyes**

Inclusion conjunctivitis

Trachoma

### **Viral Diseases of the Eyes**

Herpetic Keratitis

**Reading Assignment:** [Viral, Bacterial and Fungal Skin and Eye Infections- Chapter 21.1-21.4](#); [Viral Infections Causing Skin Rashes- Chapter 22.3](#); [Gas Gangrene- Chapter 25.2](#); [Hansen's Disease- Chapter 26.2](#)

## **Sessions 8 & 9: MICROBIAL DISEASES OF THE RESPIRATORY SYSTEM**

### **Bacterial diseases**

Group A streptococci, its complications (rheumatic fever, glomerulonephritis) & scarlet fever

Diphtheria

Otitis media

Laryngitis, sinusitis & bronchitis

Bacterial pneumonia

Pertussis

Tuberculosis

Legionnaire's disease

### **Atypical bacterial diseases**

Ornithosis

Mycoplasmal pneumonia

### **Viral diseases**

Common cold

Influenza

Viral pneumonia (Respiratory Syncytial Infection)

Hanta virus pulmonary syndrome

### **Fungal diseases**

Histoplasmosis

Cryptococcosis



Pneumocystis carinii pneumonia

Reading Assignment- [Respiratory System Infections Chapter 22](#)

## **Session 10: MICROBIAL DISEASES OF THE CARDIOVASCULAR & LYMPHATIC SYSTEMS**

### **Bacterial diseases**

Bacteremia and septicemia

Acute and subacute bacterial endocarditis

Plague (pneumonic)

Lyme disease

Anthrax

### **Atypical bacterial diseases**

Rocky mountain spotted fever

### **Viral diseases**

Epstein Barr Virus: Infectious mononucleosis/ Burkitt's lymphoma

Ebola virus hemorrhagic fever

West Nile Fever

### **Protozoan diseases**

Malaria

Toxoplasmosis

Reading Assignment: [Circulatory and Lymphatic System Infections- Chapter 25;](#)  
[Anthrax- Chapter 21.2](#)

## **Session 10: MICROBIAL DISEASES OF THE NERVOUS SYSTEM**

### **Bacterial diseases**

Meningitis

Tetanus

Botulism

### **Viral diseases**

Polio

Rabies

Encephalitis

West Nile Fever

Cytomegalovirus infection

Creutzfeldt-Jakob disease (CJD)

### **Protozoan diseases**

Trypanosomiasis/ Chagas' Disease

Reading Assignment: [Nervous System Infections- Chapter 26;](#) [Chagas' Disease- Chapter 25.4](#)



## **Session 11: MICROBIAL DISEASES OF THE DIGESTIVE SYSTEM**

### **Bacterial diseases**

Dental caries  
 Food poisonings  
 Cholera  
 Gastroenteritis  
 Bacterial Dysentery  
 Peptic Ulcers

### **Fungal diseases**

Thrush  
 Aflatoxin poisoning  
 Ergot poisoning

### **Viral diseases**

Mumps  
 Hepatitis A-E

### **Protozoan diseases**

Amebic dysentery  
 Giardiasis  
 Cryptosporidiosis

**Reading Assignment:** [Digestive System Infections: Chapter 24.1-24.5](#)

## **Session 12: MICROBIAL DISEASES OF THE URINARY/REPRODUCTIVE SYSTEMS**

### **Bacterial diseases**

Urinary tract infections  
 Vaginitis  
 Toxic Shock Syndrome  
 Syphilis  
 Gonorrhea

### **Atypical bacterial diseases**

Nongonococcal urethritis

### **Viral diseases**

Genital herpes  
 Genital warts

### **Protozoan diseases**

Trichomoniasis

### **Fungal diseases**

Vaginitis

**Reading Assignment:** [Urogenital System Infections- Chapter 23; HIV- Chapter 25.3](#)



## OBJECTIVES

The objectives listed can be used as guidelines for studying each topic discussed in the course.

### Introduction and History of Microbiology

1. Describe in one or two sentences the significance of the contributions of the following scientists to the field of microbiology: (a) van Leewenhoek; (b) Pasteur; (c) Semmelweis; (d) Lister; (e) Koch; (f) Ehrlich; & (g) Fleming.
2. Define spontaneous generation.
3. In a brief statement, describe the series of experiments disproving spontaneous generation.
4. List 3 major concerns regarding the spread and treatment of diseases caused by microorganisms.

### Bacterial Anatomy

1. Draw and describe common bacterial shapes and their arrangements.
2. Describe the structure and function of the following: (a) cell wall; (b) cell membrane; (c) glycocalyx; (d) endospores; (e) flagella; (f) inclusion bodies
3. For each of the structures mentioned in objective 2, describe how each is involved in disease processes.

### Genetic Transfer

1. Distinguish between transformation, transduction and conjugation.
2. Explain the medical significance of the 3 modes of genetic transfer mentioned in objective 1.

### Growth and Factors Affecting Growth

1. Draw and label the four phases of a typical bacterial growth curve.
2. Describe the phases of a typical bacterial growth curve.
3. List and describe four physical factors affecting microbial growth.
4. Explain why physical factors affecting growth can be used to demonstrate the human body is an excellent environment for growth of a variety of microorganisms.

### Microbial Metabolism

1. Define the following terms: (a) fermentation; (b) aerobic respiration; & (c) anaerobic respiration.
2. List the end products of (a) glycolysis; (b) Krebs cycle; (c) electron transport/oxidative phosphorylation.
3. Explain how proteins and lipids are metabolized to generate ATP.
4. Explain the significance of microbial metabolism in the identification of microorganisms.
5. List three organisms and their fermentation products used in food production.

### Immunology

1. Distinguish between contamination, infection and disease.
2. Define each of the following terms: (a) normal flora; (b) transient flora & (c) opportunistic organisms.
3. Describe the stages and infectious disease establishment.



4. List and describe the significance of three virulence factors.
5. List and describe the significance of five bacterial enzymes serving as virulence factors.
6. Distinguish between exotoxins and endotoxins.
7. Distinguish between nonspecific resistance and specific resistance.
8. Distinguish between portal of entry and portal of exit.
9. List and describe three examples of nonspecific resistance.
10. Describe the stages of inflammation.
11. Describe the classical and alternate pathway of the complement system.
12. Distinguish between humoral immunity and cell mediated immunity.
13. Distinguish between passive immunity and active immunity.
14. Distinguish between naturally acquired immunity and artificially acquired community.
15. Distinguish between an antibody and an antigen.
16. Describe in a series of steps antibody production.
17. Explain the immunological basis of vaccination against diseases such as smallpox.

### **Innate Immunity**

1. Differentiate innate and adaptive immunity
2. Describe the role of the skin and mucous membranes in innate immunity
3. Differentiate between physical and chemical factors and list three examples of each.
4. Describe the role of normal microbiota in innate immunity
5. Discuss the components of blood and their functions in the body's defense.
6. Explain how macrophages are named.
7. Explain the roles of interferons
8. Describe the complement system, including its three activation pathways.
9. Discuss the process and benefits of inflammation.
10. Describe the roles of vasodilation, kinins, prostaglandins, and leukotrienes in inflammation.
11. Explain the benefits of fever in fighting infection

### **Adaptive Immunity**

1. Differentiate humoral from cellular immunity.
2. Define antigen, epitope, and haptten.
3. Explain the function of antibodies and describe their structural and chemical characteristics.
4. Name one function for each of the five classes of antibodies
5. Describe the two major classes of major histocompatibility complex (MHC) proteins with regard to their location and function.
6. Explain the roles of antigen presenting cells such as dendritic cells and macrophages.
7. Compare and contrast three types of T cells.
8. Describe a cell-mediated immune response.
9. Describe the establishment of memory T cells.
10. Describe the formation and functions of plasma cells and memory B cells.
11. Contrast primary and secondary immune responses.
12. Contrast active versus passive acquired immunity
13. Contrast naturally acquired versus artificially acquired immunity.

### **Antimicrobial Therapy and Resistance**



1. Differentiate among disinfectants, antiseptics, chemotherapy and antibiotics.
2. Distinguish between -cidal and -static and broad vs. narrow spectrum antimicrobials.
3. Explain the 5 modes of action of antimicrobials and how they relate to selective toxicity.
4. Explain mechanisms of antibiotic resistance and strategies to prevent resistance.
5. Determine reasonable strategies to treat a particular agent of infectious disease

### Microbial Diseases of the Skin and Eyes

1. Differentiate among skin infections caused by *Staphylococcus aureus* and *Streptococcus pyogenes*, and relate signs and symptoms to bacterial virulence factors.
2. Describe the progression and etiologies of burn and wound infections.
3. Analyze the progression of Hansen's disease in terms of bacterial structure and growth conditions.
4. Compare *varicella zoster*, *rubeola* and *rubella* infections in terms of etiology, disease, and at-risk groups.
5. List the common features of herpesviruses, and distinguish among different members of the *herpesviridae*.
6. Distinguish between keratitis, conjunctivitis, and trachoma, identifying the affected area, causative agent(s), and transmission.
7. Distinguish between cutaneous, subcutaneous and systemic mycoses.

### Microbial Diseases of the Respiratory System

1. Describe four respiratory diseases caused by *Streptococcus*.
2. Identify virulent factors that enable *Streptococcus* to survive against the body's defenses.
3. Discuss the transmission of *Corynebacterium diphtheriae* and the effects of diphtheria toxin.
4. Describe diphtheria.
5. Describe the manifestation and characteristics of common colds.
6. Compare and contrast between Typical and Atypical pneumonia.
7. List at least five bacterial species that can cause pneumonia
8. Describe the features of mycoplasma pneumonia
9. Describe the features of Legionnaires disease
10. Describe the transmission and pathogenesis of *M. tuberculosis* and its effects on the body.
11. Describe the diagnosis, treatment, and prevention of tuberculosis.
12. Describe the characteristics of pertussis.
13. Describe the general characteristics of *Haemophilus influenzae*.
14. Describe coronavirus respiratory syndromes
15. Describe Pneumocystis pneumonia
16. Describe the general characteristics of Psittacosis (Ornithosis)

### Microbial Diseases of the Cardiovascular and Lymphatic Systems

1. For each disease describe the causative agent, signs and symptoms, and treatment.
2. Distinguish between bacteremia and septicemia.
3. Distinguish between acute endocarditis and subacute endocarditis.
4. Describe the following diseases including the name of the causative agent, signs and symptoms, and treatment (if any): (a) Ebola virus (b) Hanta virus and (c) West Nile virus.
5. Distinguish between bubonic, pneumonic and septicemic plague.



**Microbial Diseases of the Nervous System**

1. Describe three bacterial nervous system infections including the name of the causative agent, signs and symptoms, and treatment.
2. Compare and contrast the nervous system effects of botulism vs. tetanus.
3. List three bacteria causing meningitis.
4. Describe the worldwide significance of malaria
5. Explain how toxoplasmosis can lead to congenital defects.
6. Describe the following diseases including the name of the causative agent, signs and symptoms, and treatment: (a) rabies; (b) polio; and (c) encephalitis.

**Microbial Diseases of the Digestive System**

1. Describe two infections of the accessory structures of the digestive system.
2. Distinguish between food intoxication and food infection.
3. Differentiate between nine causes of bacterial, viral, and parasitic food and waterborne illnesses.
4. Implement precautions to prevent foodborne illness.
5. Differentiate between different forms of viral Hepatitis (A-E) with regard to virus structure, transmission, at-risk groups, and pathogenesis.
6. Describe two diseases mediated by ingestion of mycotoxins.

**Microbial Diseases of the Of the Urinary/Reproductive Systems**

1. Compare the anatomy, function, and normal microbiota associated with the male and female urogenital systems
2. Explain how microorganisms, in general, overcome the defenses of the urogenital system to cause infection
3. Name, describe, and differentiate between general signs and symptoms associated with infections of the urogenital tract.
4. Describe the progression of syphilis (primary, secondary, and tertiary)
5. Describe the effects of 2 sexually transmitted diseases on a fetus.

**BIOLOGY 5100 LABORATORY**Recommendations to the student:

- Observe all safety precautions in the laboratory. They are for your protection.
- Each student is responsible for the proper safety and maintenance of their work area.  
Bench tops and microscopes must be properly cleaned before and after use.  
Microquat disinfectant is used on bench tops.
- Wear your laboratory coat at all times while in the microbiology laboratory.
- Read the laboratory exercises before class and the textbook pages corresponding to the laboratory activities.



- If you are unsure of any of the work you are required to perform during the lab, ask your instructor.
- If you spill any bacterial cultures or make a mistake you think might be a potential health hazard, inform your instructor.
- Wash your hands with betadine before, during and after lab work.



### LABORATORY OUTLINE

**NOTE:** Due to the live cultures and complicated media preparation required for each lab, labs cannot be made up if missed.

A knee length lab coat & safety goggles must be brought to each week's lab session. Lab coats and safety goggles cannot be left in the lab. It is recommended that you wash your lab coat after each lab.

Session	Activities	Exercise # and Page (Brancaccio-Taras)
1	Introduction, Safety Guidelines, Check-in Culture Transfer Instruments Techniques & Isolation & Maintenance of Pure Cultures (Aseptic Technique only) <b>MICROBIAL MORPHOLOGY</b> Smear Preparation and Simple Staining Gram Stain Bright Field Light Microscope	v-vii 10 (p. 61)  2 (p. 12) 4 (p. 25) 1 (p. 3)
2	<b>BACTERIAL ANATOMY</b> Acid-fast Staining Endospore Staining Capsule Staining (Graham & Evans procedure) Bacterial Motility (demonstration) The Effectiveness of Handwashing	5 (p. 32) 7 (p. 43) 6 (p. 38) 8 (p. 49) 22 (p. 131)
3	Gram Stain Practical <b>MICROBIAL GROWTH</b> Environmental Factors Affecting Growth of Microorganisms: Temperature, pH, & Osmotic Pressure Cultivation of Anaerobic Bacteria (Broth & Plate cultures- demonstration)	15-17 (p. 97)  18 (p. 110)
4	<b>ISOLATION AND ENUMERATION OF MICROORGANISMS</b> Spread Plate Technique Streak Plate Technique Determination of Bacterial Numbers Bacterial Count of a Food Product	11 (p. 72) 11 (p. 70) 12 (p. 75) 42 (p. 327)



Week	Activities	Exercise # and Page (Brancaccio-Taras)
5	<b>CONTROL OF MICROBIAL GROWTH</b> Radiation (Ultraviolet Light) The Effects of Chemical Agents on Bacteria I: Disinfectants and Antiseptics The Effects of Chemical Agents on Bacteria II: Antimicrobial Agents (Kirby-Bauer method)	21 (p. 126) 19 (p. 115) 20 (p. 120)
6	<b>NORMAL FLORA, HOST DEFENSES, AND THROAT UNKNOWN IDENTIFICATION</b> Nonspecific Host Defenses: Lysozyme (demonstration) Isolation of Normal Microbiota from the Human Body (Nose, Throat, or Skin) Throat Culture Unknown Activity - Control and unknown specimens inoculated Proteins, Amino Acid & Enzymes V: catalase activity Proteins, Amino Acid & Enzymes VI: coagulase & DNase activity Selective and Differential Media (blood & mannitol salt agar only)	44 (p. 344) 37 (p. 289) 25 (p. 170) 25 (p. 169, 167) 14 (p. 87)
7	<b>TECHNIQUES TO ISOLATE AND IDENTIFY BACTERIA</b> Throat Culture Unknown Activity- Observe & Record results	25 (p. 169, 167) 14 (p. 87)
8	<b>GASTROINTESTINAL TRACT UNKNOWN IDENTIFICATION</b> Gastrointestinal (GI) Unknown Activity- Control & Unknown specimens inoculated Carbohydrate Fermentation The IMViC Tests Hydrogen Sulfide Production Motility	23 (p. 139) 23,24 (p. 144-148; 152-153) 24 (p. 159)
9	<b>GASTROINTESTINAL TRACT UNKNOWN IDENTIFICATION</b> GI Unknown Activity- Observe & Record results	23 (p. 139-142; 144-148) 24 (p. 152-153; 159-160)
10	<b>URINARY TRACT UNKNOWN IDENTIFICATION</b> Urinary Tract (UT) Unknown Activity- Control and Unknown specimens inoculated Selective & Differential Media (EMB & MacConkey only) Tryptophan Hydrolysis Oxidase Test Urease Activity Phenylalanine Deamination Nitrate Reduction	14 (p. 87) 24 (p. 152) 25 (p. 171) 24 (p. 156) 24 (p. 153) 25 (p. 172)



Week	Activities	Exercise # and Page
11	<b>URINARY TRACT UNKNOWN IDENTIFICATION</b> UT Unknown Activity- Observe & Record results	14 (p. 87) 24 p. 152; 153; 156 25 (p. 171, 172)
12	Final Laboratory Practical* Laboratory Check-Out**	

\*The final laboratory practical cannot be made up if missed. The point value for this practical (5%) will be deducted from your final grade.

\*\*For check out, empty your drawer of all slides and media and place them in the discard bin. Clean empty drawer with Microquat. Once the drawer has been cleaned, reusable materials can be returned to the drawer. Material in the slide discard bowls is placed in the discard bin. All paper trash is placed in the proper receptacle. Lastly, wash the laboratory bench top with Microquat.

